TECHNICAL EQUIPMENT REPORT NO. F-SJ-1
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PARACHUTE LANDING ROLL TRAINING DEVICE

by

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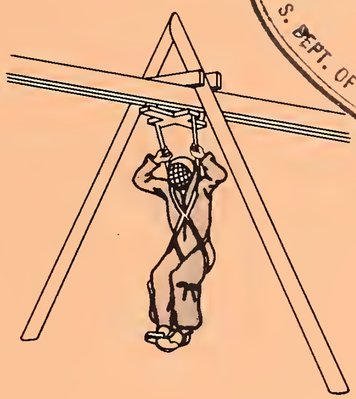

FOREST SERVICE
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WASHINGTON, D.C.

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FOR

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INTRODUCTION

The prototype of the proposed addition to smokejumper training facilities, the landing roll training slide, was completed at the Siskiyou Aerial Project in April of 1956. The device is intended to fill what many people believe to be a decided gap in smokejumper training. Past records of the Siskiyou Project show that a high percentage of all jumping injuries were leg injuries sustained during the training period, usually by new trainees. This led to the conclusion that the parachute landing roll training was insufficient. Previous reports from the Aerial Project have given many of the beliefs and reasons for the adoption of the slide. It should be sufficient to say that the main purpose is to simulate as realistically as possible, every aspect of a parachute landing except the actual landing shock. The slide also has to be acceptable from the standpoints of cost and safety. It is believed that these objectives have been satisfactorily met.

Construction details of the slide are not difficult as commonly available materials are used in all cases. The materials used, as well as the design of the component parts, could be easily varied to suit available materials in many cases. Since this is a pilot model, such design changes may be in order where improvements can be made or deficiencies in materials are noted.

CONSTRUCTION

The following pages deal primarily with design and construction details and include a cost analysis of the project, on the basis of 1956 costs. Estimated cost, including purchase of all materials, is $650. Some materials were scavenged from waste material and therefore lowered the pilot model cost.

1. Slide Support (Plates I, II, and III, photos 1 and 2).--The design of this portion of the project is probably the most critical of all, as it is here that the intended effects are either gained or lost. The one major requirement of the panel which reviewed the original suggestion was that originators provide a descent angle of 45°. A forward

speed of approximately 15 feet per second is necessary, as this roughly matches the vertical speed of the trainee after release. Such a combination of horizontal and vertical speeds will provide the 45° descent. In the pilot model, a track length of 30 feet at an incline of 13 percent, provides this velocity at the final trip (position #4). The same results could, of course, be obtained with a longer track at a smaller gradient or a shorter track at a higher gradient.

The purpose of choosing the 30 feet and 13 percent figures in the model was due mainly to the amount of drop the trainee would experience at all four trip positions. He should have a minimum drop of at least 2-1/2 feet at trip position #4, and this height, plus the additional height gained by the track gradient, gives a drop of 5-1/2 feet at trip #1. Shortening the length of track (and increasing gradient) would further increase the drop at trip #1, possibly dangerously so. Since 5-1/2 feet was not considered a dangerous drop, the track length was set at 30 feet to conserve space and materials. The rolling friction of the trolley is also a factor to be considered here. Any future installations would probably require some experimentation to determine what length and gradient would be necessary, depending on the type of track and castors used. The 45° descent angle was considered to be the main objective in construction, but by incorporating three additional trips as well as the final, descent angles of approximately 10°, 20°, and 30° are also possible. This feature, combined with the manner the trainee is hooked to the release mechanism, gives the instructor a wide range of speeds and directions of travel at his disposal (photos 5, 6, and 7).

Green Douglas-fir poles were used as uprights and must be of sufficient size and length for the purpose, in this case 12-14 inches by 20 feet. (Plates I and II). The poles were sunk 6 feet in the ground and cemented in place to provide a maximum of rigidity. The two outboard supports were built in the shape of "A" frames, which serve two major purposes. They provide a very rigid construction against lateral movement and thus maintain alignment. And, they allow enough room at ground level for the trainee to roll without danger of colliding with the posts (photo 1). The first upright was erected vertically for ease in attaching the hook-up platform and to allow sufficient headroom for hooking up (Plate III, photo 3).

Beams 3 by 10 inches were used as stringers or track supports. (Plate I). Ideally, these should be 30 feet in length, but as this length was unavailable, the stringers were joined at the center support and fastened with strap steel. Two such stringers

were used and were underslung to 3- by 8-inch crossbeams on all three uprights. The track was then mounted between the two stringers and fastened alternately every 3 feet with track hangers. The purpose of using two stringers here was aimed at preserving alignment in case of warpage. This alignment was further assured by welding the track sections together after installation.

The hook-up platform was constructed mainly of 2- by 4-inch and 2- by 6-inch lumber and is not critical in size. It should be high enough to allow the trainee to be hooked up with ease, but low enough to enable him to clear the platform by lifting his legs slightly when hooked up (Plate II, photo 3).

In the interests of safety, bolt construction was used throughout the pilot model, except in the hook-up platform.

2. <u>Release Mechanism</u> (Plate IV, photos 4 and 8-11).--The release mechanism was designed in the shape of the letter "X". By providing release points on the end of each arm, it is possible to give the trainee four directions of travel; that is, forward or backward by use of the lateral arm, or to either side by use of the longitudinal arm. The method of release is the same regardless of the trainee's position. In order to provide a simultaneous release from both arms, four retractable rods (operating rods) were used and were attached to a 3 3/4-inch rotating wheel in the center of the main body. Any movement of the wheel retracts all four rods a proportionate amount simultaneously (photo 10).

There are several rather critical dimensions involved in construction, the first of which is the travel of the trip arm (see plan). The arm must be long enough to insure a positive contact with the trip and must pivot enough to clear the trip without binding during the releasing operation. The arc travel of the trip arm is governed by a stop welded to the rotator wheel which operates between the sides of the main frame and is positive in either direction. The length of the stop determines the amount of travel of the trip arm. In the pilot model, an arm length of 6 1/4-inches and an arc travel of 50° were used to accomplish this purpose.

The length of travel of the operating rods is also important. They must be retracted enough to assure release, but not so far as to allow them to slip out of their guides; in this instance, seven-eighths of an inch. The amount of rod travel is determined by their point of attachment on the rotator wheel. As the distance from the hub to the point of attachment increases, the amount of rod travel increases. For a desired rod travel of seven-eighths of an inch, the rods were attached to the rotator 1 1/2-inches from the hub.

The main body of the device was constructed of 4-inch channel-iron, which was cut and welded at the center in the "X" form. Three-eighths inch flat stock steel was used for the operating rod guides and castor supports and these are welded to the main frame. To provide a bearing for the trip arm shaft, a piece of stock 1-inch steel tubing was welded to the body and fitted with a Ford spring-shackle bushing. The bushing was then reamed to accommodate the shaft to which the rotator wheel was attached at the bottom and the trip arm at the top. The operating rods themselves are formed from 5/16-inch, cold-rolled, steel doweling and are held in place by washers and cotter pins. A return spring is used to hold the mechanism in a closed position at all times.

3. <u>Trip Mechanism</u> (Plate V, photos 1, 5, 6, and 8).--As has been previously mentioned, there are four trip positions situated along the track (Plate I). The operator may release the trainee at any of the four positions desired. In order to accomplish this, the first three trips were made retractable and are connected by cable to the operator's position. Since these trips are lowered as a unit, the operator must wait until the trainee has cleared the trip preceding the intended one before lowering the trips. These trips are spring-loaded to remain in the retracted position except when in operation. The final trip (#4), remains in the lowered position at all times to assure that the trainee cannot pass without being released. For this reason, it is not controlled by the operator. Trip #4 must also pivot, however, to allow the release mechanism to be returned. It is, therefore, retractable, but is spring-loaded to remain in the lowered position.

Lengths of 1/4- by 1 1/4-inch strap iron were used for the trips themselves and 5/8-inch machine bolts were used for pivots. The pivot bolts were also used to fasten the trips in the proper position on the 3- by 10-inch stringer. One-eighth inch aircraft cable was used as control cable.

4. <u>End Bumper</u> (Plate VI, photo 1).--This unit was intended primarily as a safety measure should the trainee accidentally pass all trips, which he cannot do, barring mechanical failure. It also serves as a stop for the release mechanism which in itself would deliver a considerable jar to the support if not cushioned.

An automobile, front-suspension, coil spring fastened to a welded bracket on the track was used for this purpose. A block of hardwood was fastened to the front of the spring to avoid battering of parts. The alignment of the device during recoil was assured by mounting an additional 2 3/4-inch track castor on the hardwood block.

5. Trolley End Latch (Plate VII, photos 8-9).--The purpose of the end latch is to hold the release mechanism in place at the top of the track until released by the operator. This aids considerably in hooking up and allows the operator to deaden any lateral swing of the trainee before releasing him.

   The device is built on the order of a common cam latch and is not critical in any dimension so long as it is adequate for the job. The latch on the pilot model was constructed from 3/8-inch stock flat iron and is spring-loaded to remain closed.

PRELIMINARY REPORT ON ROLL TRAINING SLIDE

At the end of the 1956 season, the roll training slide was evaluated and considered to be a very important asset to the smokejumper training equipment.

It was used as a third phase of training in the correct parachute roll. The trainees were given initial instruction on the ground with and without suits, and after they were considered proficient enough in this phase they were advanced to the rope swing. When they had completed the rope swing training, they were advanced to the roll training slide and from there to the actual parachute jump.

A total of 39 jumpers, including all experienced and inexperienced jumpers, were given this training. In the initial training the trainees were dropped only in the forward position and were notified which trip was to be used. As the training progressed the positions were changed to include back and side rolls. They were also tripped at different points at the instructor's discretion. This was to teach the trainee to be alert and to automatically go into the roll as his feet contacted the ground from any position and at any time.

The comments received from all trainees, both experienced and inexperienced, were very favorable, and there was a noticeable improvement in landing on the actual jumps.

As for the jump accident record this season, 2 injuries out of a total of 192 training jumps were experienced. These were both attributed to poor landing attitudes. One was on the trainee's first jump, and the other was on the second jump. In both instances it is felt that fear caused them to "tighten up" and no amount of this kind of training would have made any difference.

At the end of the 1956 season, the Project recommended another season's trial use before adoption Servicewide.

FINAL REPORT ON THE ROLL TRAINING SLIDE

The 1957 evaluation of the slide unit developed the following observations and comments:

The slide has been in use for two seasons and has served in the training of 93 men during that time. It has been favorably received by both experienced and inexperienced jumpers as having merit in landing roll training; however, it does not actually simulate a parachute landing. The following points are the general impressions gained from its use:

1. It does not instill the feeling of an actual parachute landing.

2. It is somewhat harder to execute a roll from the slide than on an actual jump in most cases.

3. It does support the jumper in the same manner as a parachute and gives him approximately the same landing attitude of an actual jump.

4. It does allow a variety of speeds and attitudes that the jumper may experience during an actual jump.

The lack of similarity to a parachute landing is considered due to the lack of a vertical drop. While the trainee is given the approximate landing attitude of an actual jump, he does not have any appreciable vertical descent until he is released from the slide, therefore, he lacks the sensation of a parachute fall. While this factor is more a psychological one, it none the less destroys the illusion of an actual landing.

The difficulty of executing a landing roll from the slide is considered due to the use of a sawdust pit under the device. The Allen type landing roll requires the trainee to pivot on his feet at the moment of contact with the ground. This is much more difficult to do on a soft surface such as sawdust. A possible remedy would be to remove all or most of the sawdust, possibly in the latter stages of training.

The original report made at the time of construction gave most of the reasons for testing the slide, and what was expected to be accomplished by its use. It should be sufficient to say that, excepting the above points, the device has performed as intended.

Results of the use of the slide appear to be favorable. Foreman James C. Allen comments that the landing rolls on training jumps appear to be better than average. This fact is apparently borne out by a reduction in landing injuries. During the period from 1949 to 1955, a total of 20 injuries attributed solely to landing

were sustained in 1,858 jumps of all types. This gives an injury-jump ratio of 1:93. For the seasons of 1956 and 1957, the figures are: 6 injuries in 893 jumps for a ratio of 1:148. Unfortunately, no breakdown is available for training jumps alone for 1949 and 1955; however, it is known that the majority of injuries during this period occurred in training. For the 1956-57 period, 2 injuries occurred in 583 training jumps for a ratio of 1:291. Inasmuch as the slide has been in use for only two seasons, the above figures may not be as significant as they appear; however, there does seem to be a definite improvement in landing roll techniques.

No revisions have been found necessary in the design of the slide. All components have performed as intended and show no wear other than that expected through normal use. In construction, one revision is suggested in any future models. The supports used in the pilot model were green Douglas-fir poles. These have proved to be too limber and should be replaced by either timbers or metal supports. Metal, of course, has the added facility of being more durable.

SUMMARY

In summary, the slide does not instill the feeling of an actual parachute landing, but apparently is filling a gap in smokejumper training not presently covered by other means. The construction of any future models of the slide should be determined by the interested unit's evaluation of the slide's merits versus its drawbacks.

#1: Side view of slide in operation. The four trip positions can be seen along the slide support (trip #2 hidden by center post). End bumper visible at right.

#2: End view showing trainee in motion and position of operator. Construction details of platform and slide support are shown.

#3: Trainee in position
just prior to release.

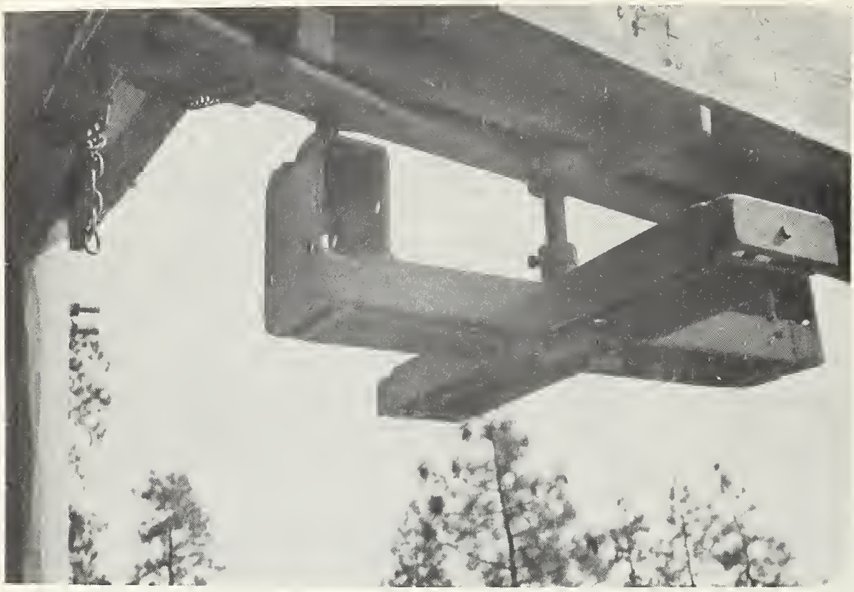
#4: Trainee in forward roll
position just prior to
release. Slide is held
in place by the trolley
end latch. Fake risers
are held in place by
trainee until operator
locks the mechanism.

#5: Trainee at the moment of release from trip #3. Trip and trip arm are still in contact. Both risers have just been released from the mechanism. Speed here approximately 10 m.p.h.

#6: Trainee just after release from trip #3. Detail shows trip #3 in lowered position and spring which holds trips 1, 2 & 3 raised except when in operation.

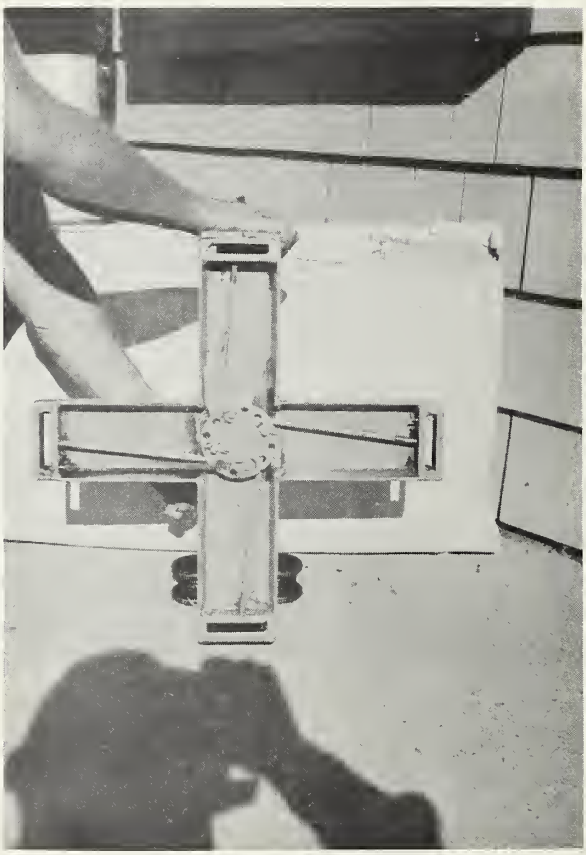
#7: Trainee after release from trip #2 (visible in extreme upper left).

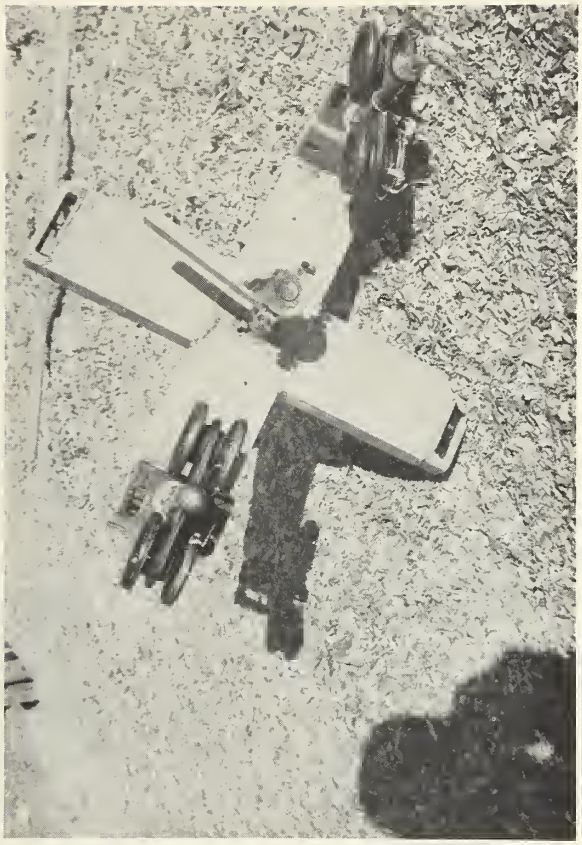
#8: Operator's position showing controls, trolley and latch control in right hand, trip control in left.



#9: Release mechanism in place at top of slide - Retained in position by end latch.

#10: Bottom view of release mechanism in open position. Spring at left normally holds mechanism closed. Additional holes in rotation wheel were for experimental purposes.





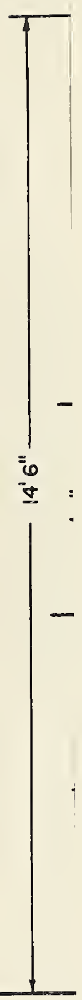
#11. Top view of release mechanism showing trolley casters attached and detail of trip arm.

BILL OF MATERIALS AND COSTS

(Landing Roll Training Slide, Installed at the Siskiyou Aerial Project, April 19

Material	Amount	Costs	
Support (Plates I, II, and III)			
Construction lumber			
3" x 10" - #1 Common	160 bd. ft.	$ 84/M	$13.44
3" x 6" - Select struct.	63 " "	105/M	6.62
4" x 4" - #2 Common	70 " "	80/M	4.91
2" x 8" - #2 Common	99 " "	80/M	7.46
2" x 10" - #2 Common	33 " "	80/M	2.64
2" x 4" - #2 Common	139 " "	80/M	11.12
			$46.19
Poles	12-14" x 20'	No charge	
Trolley end latch (Plate VII)			
Iron	14 lbs.	$ .18/lb.	$ 2.52
Return spring	1	.30	.30
1/2" x 5" Machine bolt	1	.10	.10
3/8" x 5" Machine bolts	2	.08	.16
Control cable	1	1.00	1.00
Welding	1/2 hr.	4.00	4.00
			$ 6.08
End bumper (Plate VI)			
3" Trolley castor	1	No charge	
Auto coil spring	1	No charge	
3/8" x 2" Machine bolts	4	Forest Service supply	
3/8" x 4" Lag screws	4	Forest Service supply	
Iron	5 lbs.	$ .18/lb.	$ 0.90
Welding	3 hrs.	4.00	12.90
			$13.80
Trip mechanism (Plate V)			
1/4" x 1/4" Strap iron	4 ft.	No charge	
5/8" x 4" Machine bolts	4	$ .21	$ 0.84
3/8" x 3" Lag screws	8	.06	.48
1/4" x 5-1/2" Lag screws	4	.10	.40
1-1/2" Pulley	1	.40	.40
Control cable	1	1.00	1.00
Springs	2	.30	.60
			$ 3.72

Material	Amount	Costs	
Release mechanism (Plate IV)			
4" Channel iron	4 ft.		
1-3/4" Strap iron	3"		
5/16" Steel doweling	4"		
5/8" Steel shaft	8"	No charge, F. S. supply	
Screen door springs	2		
3" Trolley castors	2		
Ford spring shackle bushing	1		
Grease fitting - Zerk	1		
5/16" Steel washers	4		
Labor	24 hrs.	$ 3.00/hr.	$ 72.00
Miscellaneous			
1/2" Guy cable	60 ft.	No charge	
1/2" Cable clamps	8	No charge	
Cresote	2 gal.	$ 1.89	$ 2.78
Concrete	2-1/2 yds.	16.00/yd.	40.00
Strap steel	7-1/2 lbs.	.16/lb.	1.20
Cutting and drilling	1/4 hr.	4.60/hr.	1.15
Sawdust	3 yds.	2.00/yd.	6.00
1/2" Thimbles	4	.18	.72
1/2" x 12" Machine bolts	4	.34	1.36
1/2" x 10" Machine bolts	2	.29	.58
#16 Box nails	5 lbs.	.17/lb.	.85
40d Nails	2 lbs.	.16/lb.	.32
Bolt eyes	4	.15	.60
5/16" x 3-1/2" lag screws	4	.06	.24
5/8" x 4" Machine bolts	26	.21	5.46
5/8" Lock washers	30	.015	.45
1/2" Flat washers	1-1/2 lb.	.51/lb.	.77
1/2" Lock washers	20	.01	.20
1/2" Flat washers	8	.015	.12
1/2" x 6" Machine bolts	4	.32	1.28
1/2" Nuts	8	.04	.32
Trolley track Wilcox #232	30 ft.	No charge	
Track hangers	18	No charge	
1/2" Drill Bit	1	2.80	2.80
3/8" Drill Bit	1	1.59	1.59
			$ 68.79
Labor			
1 GS-6, 15 days, @$4,265/annum			$244.58
1 GS-5, 6 days, @$4,345/annum			100.68
			$345.26
Total cost of project			$555.84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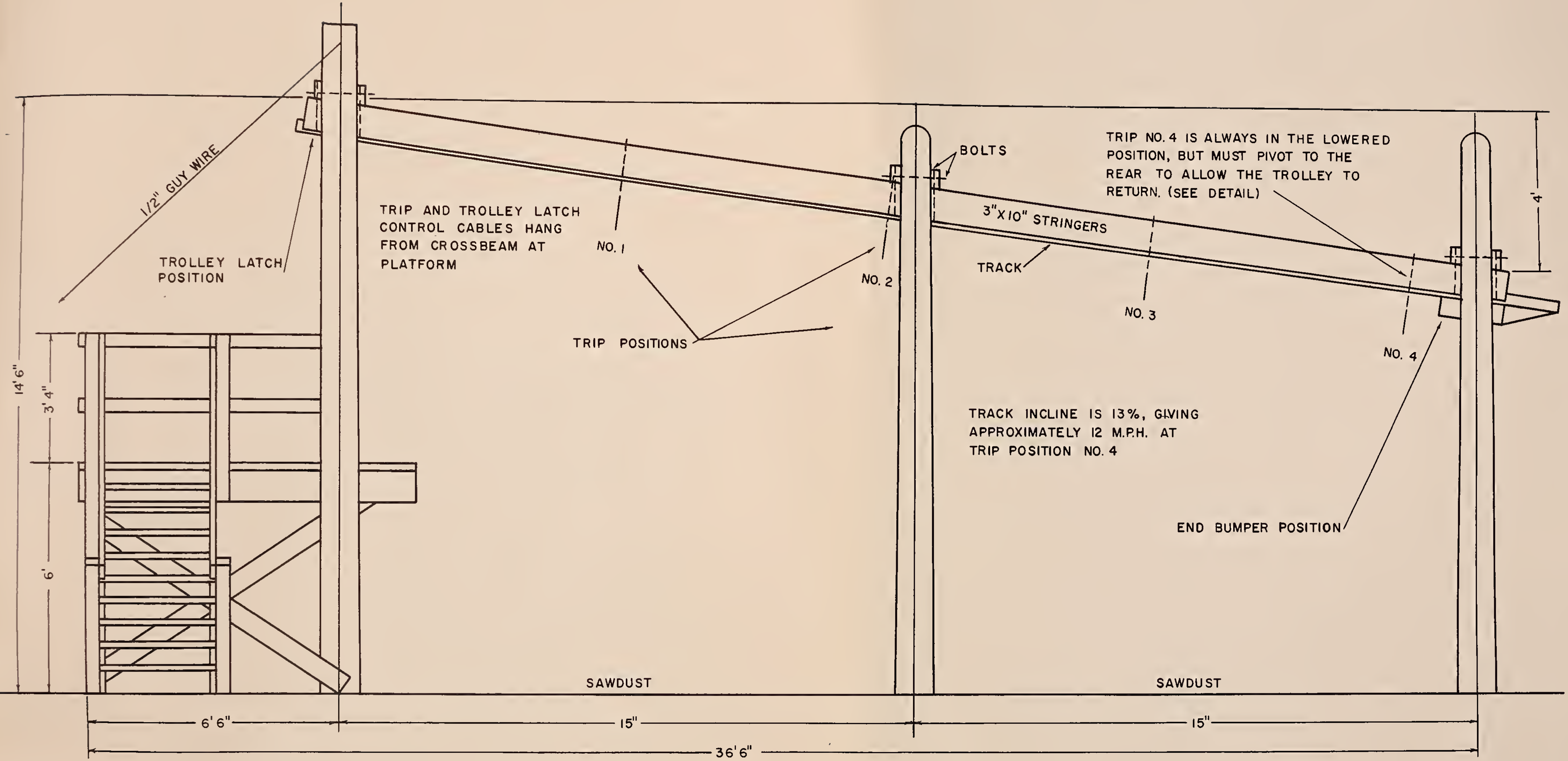


PLATE I LANDING ROLL TRAINING SLIDE SUPPORT

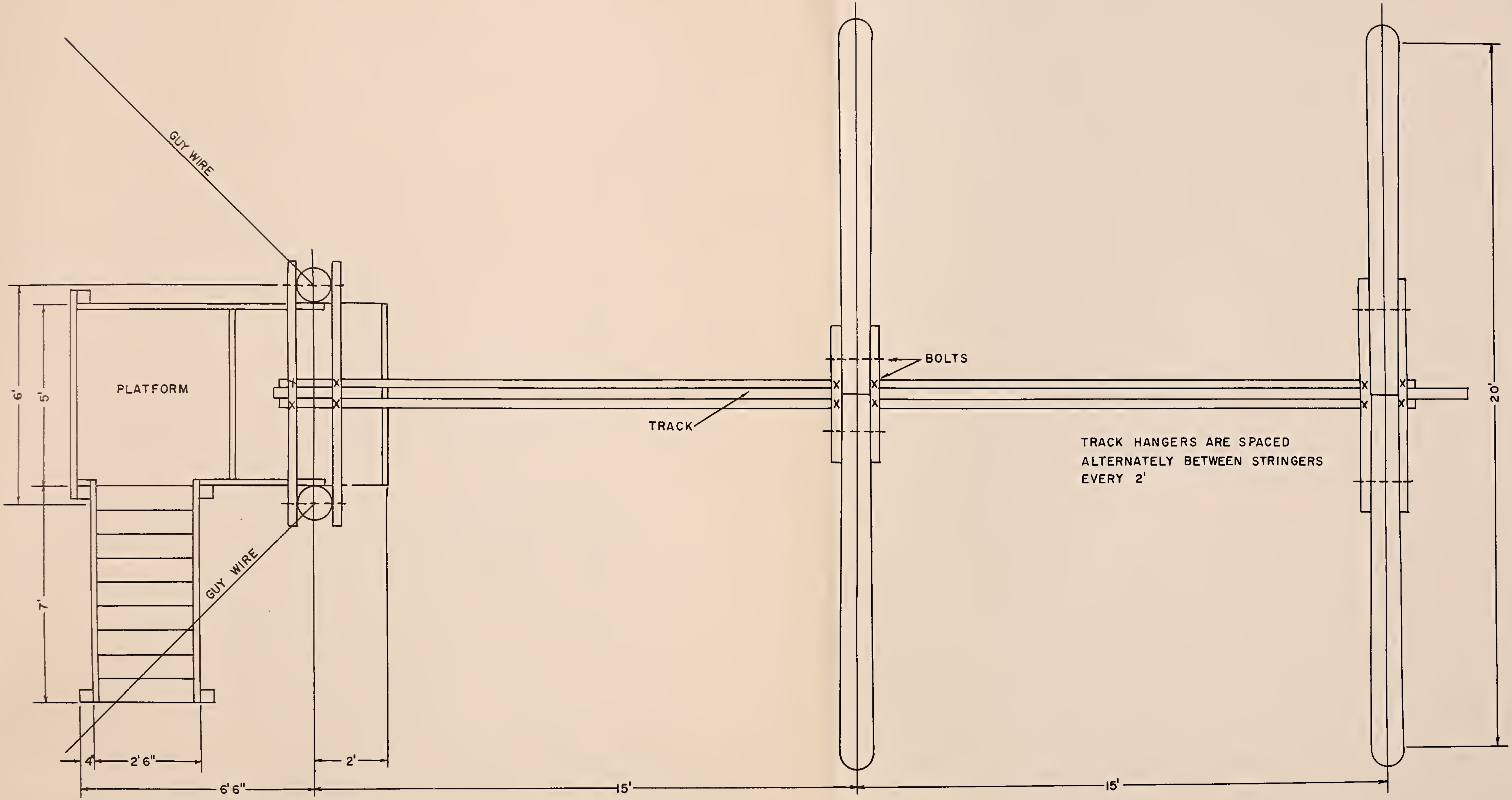


PLATE II LANDING ROLL TRAINING SLIDE SUPPORT (PLAN)

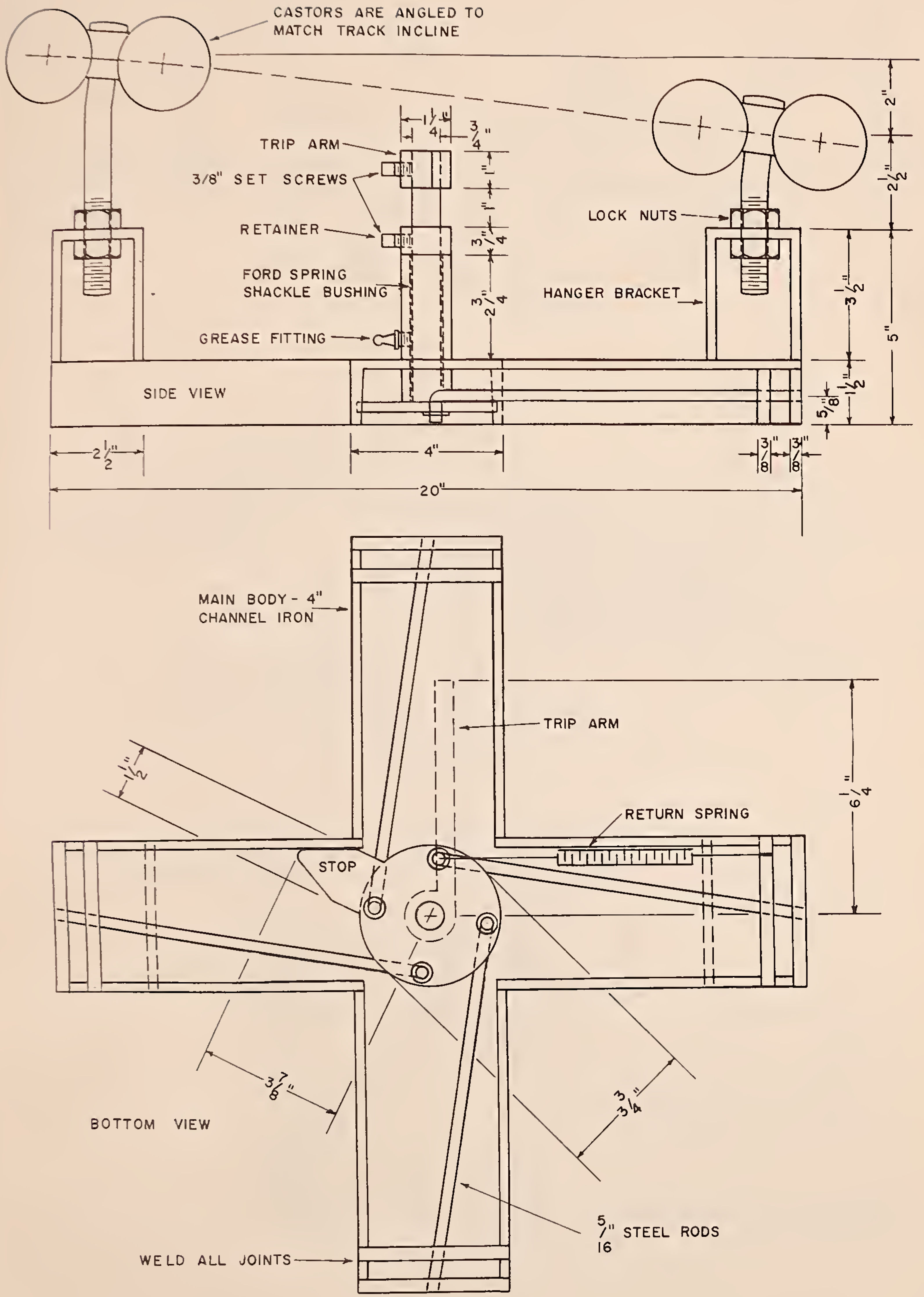
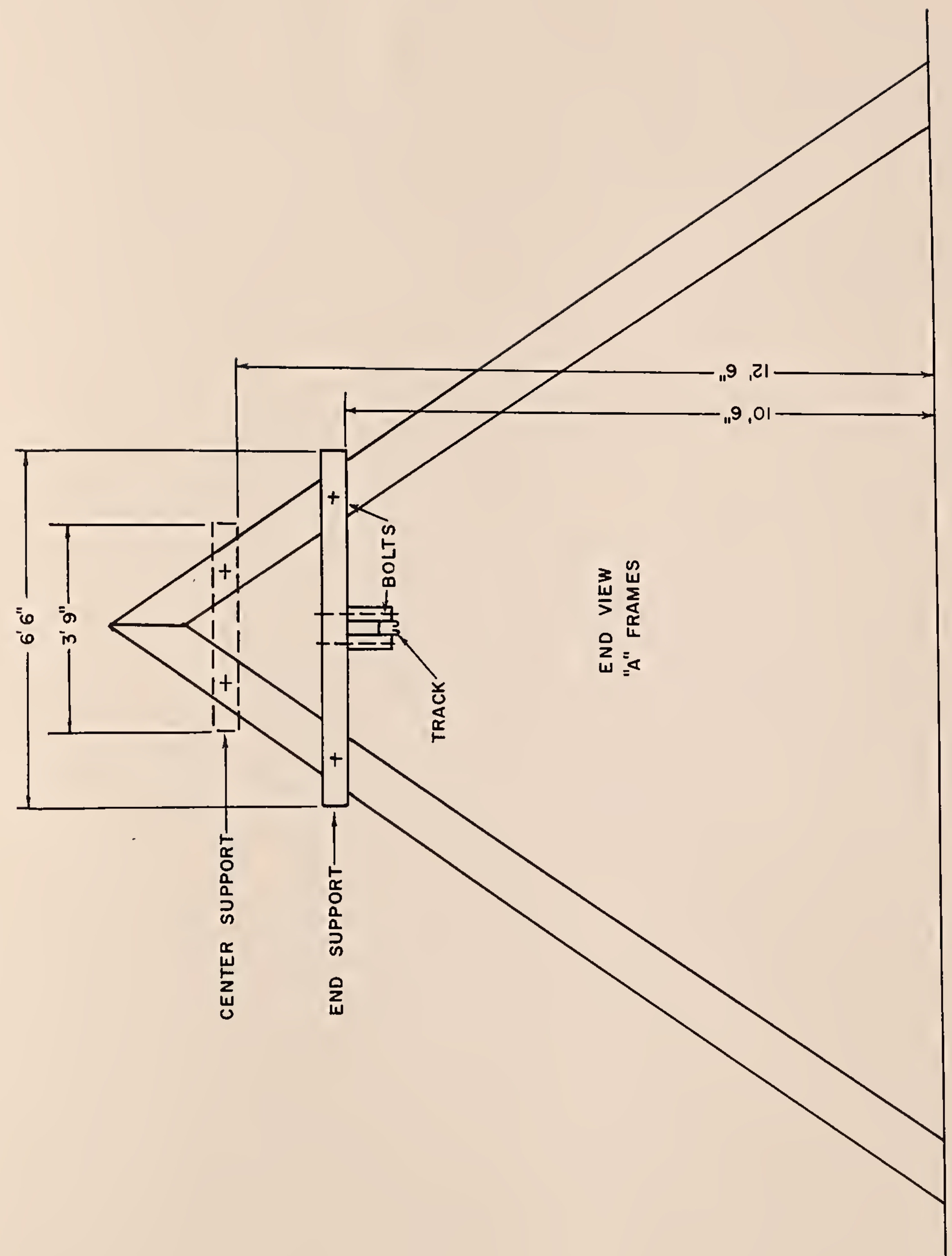
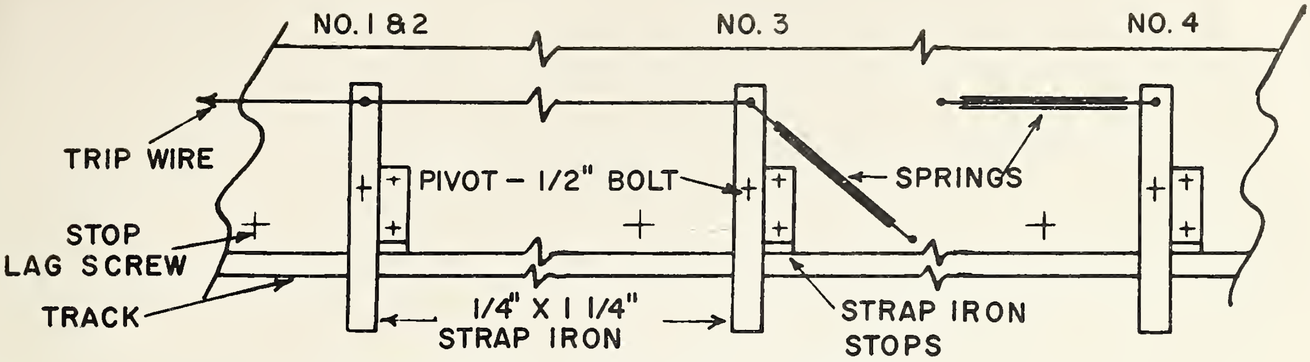


PLATE IV LANDING ROLL TRAINING SLIDE RELEASE MECHANISM

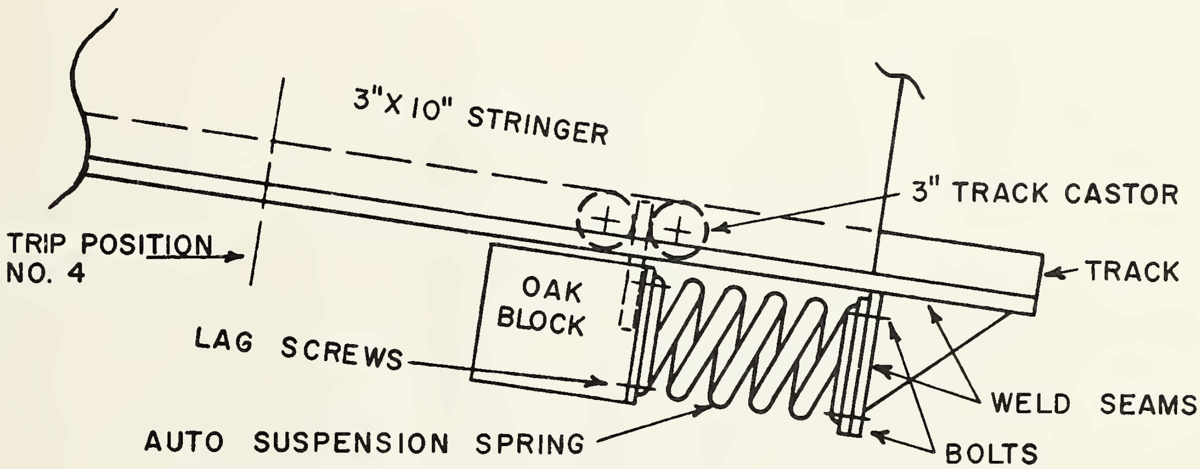


LANDING ROLL TRAINING SLIDE SUPPORT
PLATE III



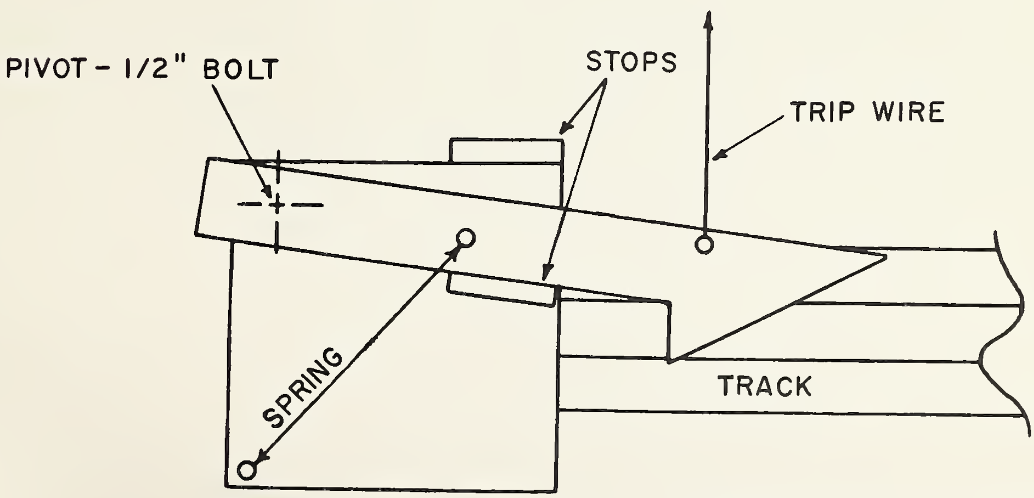
TRIP DETAIL – SIDE VIEW (LOWERED)

PLATE V



END BUMPER DETAILS – SIDE VIEW

PLATE VI



TROLLEY LATCH DETAIL – BOTTOM VIEW (CLOSED)

PLATE VII

LANDING ROLL TRAINING SLIDE (DETAILS)